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A study of relation between comparative advantage indices of wheat and support policies by using econometrics approach

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Abstract

Comparative advantage is a term used to describe a production capability with low level output price and minimum opportunity costs. This study was done to evaluate the importance of maintaining comparative advantage for a strategic crop such as wheat in terms of changes and contributing factors over time. In this study data has been calculated and investigated by comparative advantage indices such as Net Social Profit and Domestic Resource Cost for the period of 1984-2010 in Iran. Following a stationary test and an econometrics model the Vector Error Correction Model (VECM) was applied to analyze the relation between guaranteed price policy, producer support estimate index and subsidies by comparative advantage indices. Results showed that as producer support is increased, comparative advantage decreased and the use of cheaper price inputs led to less competitiveness although the guaranteed price policy led to an improvement in scale advantage index, but had no positive effect on the efficiency advantage index. This study suggests that there is a need to perform investigations considering the relationship of cost and world market price and a change from direct support of the agricultural sector to indirect support in the form of structural support, and finally with the implementation of targeted subsidy policy, these multiple goals can be achieved

Keywords: Comparative advantage, vector error correction model, opportunity cost, price policy, wheat

Introduction

In economics, the theory of comparative advantage refers to the ability of an entity (individual, company, or country) to produce goods or services at a lower opportunity cost than other producers. It is the ability to produce a product with a higher relative efficiency than one's trading partner, given all other products that could be produced. It can be contrasted with absolute advantage, which refers to the ability of one producer of particular goods or services to produce at a lower absolute cost than another does. Comparative advantage is also known as comparative cost, the law of association or the Ricardian Law of Association (Ludwing, 2011). Comparative advantage, in turn, is explained by differences in national characteristics, most notably variations in technology, factor endowments or tastes and preferences (Findlay, 1995)

Comparative advantage provides an important conceptual foundation for international trade theory. For simplicity, assume that there are two countries producing and consuming two goods. Let P_{ij} be the price of good i in country j (i,j = 1,2). Then country 1 has a comparative advantage in good 1 if, in autarky, $P_{11}/P_{21} < P_{12}/P_{22}$. In other words, a country will have a comparative advantage in the production and export of goods that have lower relative autarky prices as compared to other countries (Wesley et.al, 2000) However, the main point is that, this advantage is not permanent and can be transferred from one crop or even from one area to another within a country. Therefore, the determination of superiority in production has undeniable importance. How-

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ever, achieving self-sufficiency in strategic crops such as wheat is a serious consideration for policy makers in the agricultural sector, the effect of policy intervention targeted to supporting this sector is considerable; for example, subsidies for agricultural inputs can be introduced or prices of produce can be guaranteed, like currently guaranteed prices for wheat in Iran.

Previous studies have emphasized that such supporting policy can contradict the principle of comparative advantage (Shahnoshi *et al.,* 2007) as government policy leads to unfair and non-optimal allocation of limited resources in the agricultural sector. So with regards to the importance of this subject, the main aim of this study is an investigation of support policies and comparative advantage on irrigated wheat production as a major source of food. This paper divides the topic into several sections and the specific purposes of the study are as follows:

- To calculate and analyze comparative advantage indices, both physical and cost indices are evaluated.
- To investigate comparative advantage indices relationship and protection measures for wheat such as support price and subsidies are applied to econometrics methods.
- To determine any difference in comparative advantage indices with reference to different development programs, analysis was done for each of these five-year programs.

The analysis is based on data for wheat production and the current trend that supports producers in Iran for the period 1991 to 2005 compiled from published sources such as the Ministry of Agricultural Jihad and the Customs Institution of Iran. Time series data on support prices were collected from published data of the rural cooperation organization. Some research has been done that relates to comparative advantage issues using different indices.

Over the last few decades, many surveys have been done on this topic; most empirical efforts to test for the presence of comparative advantage have been based on different indices such as domestic resource cost (DRC), social cost-benefit (SCB) or net social profit (NSP). In the agricultural sector, the following three indices have been used in other studies: Masters and Winter-Nilson (1995) computed DRC and SCB indicators for Kenya and debated that the social cost-benefit ratio provides more accurate ranking of the comparative advantage of alternative activities. Another study has used policy analysis matrix (PAM), which is an approach to investigate comparative advantage, for instance Fang and Beghin (2000) attempted to investigate comparative advantage and trade in agricultural products in China the study used policy analysis matrix (PAM) for analysis. The results showed that China has advantages in terms of labor and no advantage in products associated with the earth. Some recent papers that applied this method include those of Kapaj *et al.,* (2010) Alsharif (2008), Rezaee *et al.,* (2010). This approach has been used in other study to investigate the comparative advantage of Pistachio and Iranian government policy regarding pistachio production (Amirteimoori and Chizari, 2004). As it is obvious, similar methods have been applied in these afore-mentioned studies. While in this paper, the authors attempt to investigate the same theme from a different aspect; via an econometrics approach to investigate the relationship between comparative advantage indices and government policies by the use of time series data that is described in the next section.

Methodology

Two types of indices may be applied to calculations of comparative advantage. Physical indices are Efficiency Advantage Index (EAI), Scale Advantage Index (SAI) and Aggregated Advantage Index (AAI) which measure plant concentration of a crop, its operation in an area. The second group of indices is based on the Ricardian approach, and includes Net Social Profit (NSP), Domestic Resource Cost (DRC) and Social Cost-Benefit (SCB) which estimate the net profit of an activity based on shadow price and opportunity costs. Since time series data have been used in this study, the following modified formulas have been used to determine which years have been the most efficient.

$$EAI_{tw} = \left[\frac{AP_{tw}}{AP_{t}} \Big/ \frac{AP_{ow}}{AP} \right] \qquad (1)$$

Where EAI_{to} = the Efficiency Advantage Index of the jth crop in the ith region;

AP_{tw}= the average yield of the wheat crop in the year t;

AP_{t} = the average yield of all crops in the year t;

AP_{w} = the average yield of the wheat crop in all years under study;

AP = the average yield of all crops in all years under study.

If $EAI_{tw} > 1$, then the yield of the wheat, relative to all other crops in year t, is higher than that of national average of other under study years, and vice versa.

The SAI shows the extent of concentration of one crop in a region, relative to the national average, but in this paper all regions in Iran are under evaluation in the study and wheat concentration in year t is compared with all other years. So:

$$SAI_{tw} = \left[\frac{GS_{tw}}{GS_t} \Big/ \frac{GS_w}{GS} \right] \qquad (2)$$

Where SAI_{tw} = the Scale Advantage Index of the wheat crop in the country in the year t;

GS_{wo} = the planted area of wheat crop in the year t;

GS_t= the total planted area of all crops in that year;

GS_w = the average planted area of the wheat crop in all years;

GS = the average planted area of all crops in all years

If SAI_{tw} >1, then the degree of concentration of wheat crop in the year t, is higher than that of other crops, implying that farmers in that year preferred to grow more wheat than other crops or vice versa.

The AAI is simply the geometric average of the EAI and SAI:

$$AAI_{tw} = \sqrt{(EAI_{tw} \times SAI_{tw})} \qquad (3)$$

If AAI_{tw} >1, then the wheat crop in the year t is considered to have a comparative advantage over other years under evaluation and vice versa. As EAI indicates yield differentials and SAI indicates relative production shares, their geometric average could be taken as a kind of aggregated indicator of comparative advantage (Zhong *et al.,* 2002). NSP measures the net social gain produced from an economic activity defined as the difference between values of products and associated opportunity costs of inputs:

$$NSP_t = (P^b_{wt} - \sum a_{jt} P^b_t - \sum b_{ot} P^s_t)\, Y_{wt} \qquad (4)$$

Where NSP_t = the net social profit generated in year t;

P_{wt}^{b}= the border price of wheat in year t.

a_{jt} = the quantity of non-tradable input used to produce one unit of a crop;

P_t^{b}= the border price of non-tradable input;

b_{ot} = the quantity of tradable input used to produce one unit of a crop;

P_t^{s}= the opportunity cost of tradable input; and

Y_{wt} = quantity of the product produced in the year t;

the other index is domestic resource cost, DRC measures the necessary total costs of domestic resources required in order to earn (or save) one unit of foreign currency (Zhong *et al.,* 2002) and SCB is the ratio of total social cost to benefit ratio to produce wheat, both indices can be derived from equation (4)

$$DRC_t = (\sum b_{ot} P^s_t / P^b_{wt} - \sum a_{jt} P^s_t).E^*) \qquad (5)$$

$$SCB_t = (\sum b_{ot} P^s_t + (\sum a_{jt} P^b_t).E^*) / P_{wt}.E^* \quad (6)$$

Where E* is equal to shadow exchange rate

The following conclusions also hold:

If $DRC_t = 1$, then the production of wheat y is at break-even point at year t.

If $DRC_t < 1$, then the production of wheat has a comparative advantage at year t;

If $DRC_t > 1$, then the production of wheat has a comparative disadvantage at year t

About SCB_t it should be mentioned that, this index may not be smaller than zero because it is the ratio of cost to profit and so:

If $SCB_t = 1$, then the production of wheat y is at break-even point at year t.

If $0<SCB_t < 1$, then the production of wheat has a comparative advantage at year t;

If $SCB_t > 1$, then the production of wheat has a comparative disadvantage at year t (Zhong *et al.,* 2002)

It is also necessary to extract data for a shadow price of output, tradable and non-tradable inputs, and a shadow exchange rate. Indicated inputs are divided into two groups; non-tradable inputs; labor, water, land and some parts of machinery and tradable inputs; chemical fertilizer, pesticides and parts for machinery. For the purpose of computing a shadow price of water, the highest amount of paid cost was taken, current resources included land, taking the average rent for each hectare as renting land appeared to be the most appropriate for expressing opportunity cost and shadow price of land (Abedi *et al.,* 2010). The total cost for non-machine work each year was considered as a labor force shadow price. In order to compute the shadow price of imported output and tradable inputs, their CIF[1] price was multiplied by the calculated shadow exchange rate. Shadow exchange rates were calculated using equal purchasing power (ppp) theory in a comparative manner. This equation is expressed as:

$$\text{Shadow exchange rate} = \frac{PI}{PI^*} * E \qquad (7)$$

Where:
PI = Foreign wholesale Price index
PI* = Domestic retail price index
E0 = Real exchange rate

After computing these above-mention indices, and with regard to the time series nature of data, their stationary conditions were tested before applying them in an econometrics model to investigate their relationship with a guaranteed price and other indexes of supporting policies; for this purpose augmented dickey-fuller method was performed as a unit-root test. With regard to the stationary degree of variables, Error Correction Model (VECM) is applied to describe the relation between variables. The specification of our model is a 2-dimensional (2*1) vector autoregressive model that can be expressed as:

$$\Delta Yt = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \pi Y_{t-1} + \mu_t \qquad (8)$$

The π matrix provides information about the long-run relationship between independent and explanation variables (Ho & Siu, 2007). Two test procedures were used to test the number of co-integrating vectors or equivalently, the rank of π in the VECM model: the trace test and the maximum eigenvalue test, of which more information is provided in the next section.

Results and Discussion

To calculate indices of comparative advantage and then to examine correlations between these indices and protectionist policies (such as guaranteed prices and subsidies paid to the inputs) it was necessary to estimate shadow prices of tradable and non-tradable inputs and a wheat crop. The results of these indices are shown in Table 1. Required data such as amounts of inputs were not available to calculate cost indices during 1980-84, for these years a dash is used.

[1] Cost Insurance Fee

In Table 1, Scale Advantage Index or SAI represents the degrees of wheat cultivation during the period under evaluation. As the numbers indicate, in some years, this index is greater than one and this shows the preference of farmers for planting wheat rather than choosing other crops. In some years, efficiency advantage index or EAI is more than one, which implies the average yield of wheat crops in that year is greater than for other years. Aggregate advantage index or AAI, the geometric means of SAI and EAI, are shown in the Table 1. In those years in which this index is greater than one, wheat crops had more comparative advantage than other years for example in the period 1988-1989.

Social net benefit index (NSP) is the another comparative advantage index that identifies differences between product value and opportunity cost, so when it is positive it can be concluded that the proceeds of wheat production are more than its costs, which represents the profitability of wheat cultivation. However, in the five-year period preceding 2009-2010, the sign of this index is negative indicating that comparative advantage has been missed in those 5 years. For more explanation, attention needs to be given to the components of the NSP index like production cost or shadow price of wheat. In figure 1 the trend of NSP is drawn in front of production cost, as it is obvious that the trend of production cost is ascending, while the shadow price of wheat isn't increasing to compensate the cost effect figure 2), in order to maintain competitive power of wheat it is necessary to control the increase of production cost. Two other indices; domestic resource cost (DRC) and Social Cost benefit (SCB) confirm these results, in other words, since DRC and SCB are more than one, it can be concluded that there was an absence of comparative advantage during 2005-2010.

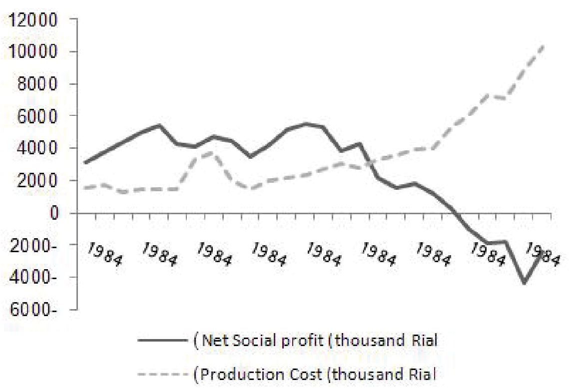

Figure 1. The trend of NSP and production cost of wheat

Table 1 Comparative Advantage Indices Results

Year	Cost Indices			Physical Indices		
	SCB	DRC	NSP	AAI	EAI	SAI
1980-81	-	-	-	0.66	0.546	0.798
1981-82	-	-	-	0.773	0.647	0.923
1982-83	-	-	-	0.879	0.705	1.097
1983-84	-	-	-	0.851	0.652	1.11
1984-85	0.333	0.027	320.52	0.854	0.667	1.094
1985-86	0.323	0.023	378.57	0.859	0.696	1.061
1986-87	0.232	0.018	444.11	0.889	0.772	1.023
1987-88	0.23	0.018	502.73	0.91	0.808	1.025
1988-89	0.213	0.015	550.83	1.07	1.132	1.011
1989-90	0.253	0.024	436.29	1.283	1.781	0.924
1990-91	0.442	0.023	417.72	0.932	0.907	0.958
1991-92	0.445	0.023	475.72	1.298	1.742	0.967
1992-93	0.311	0.028	448.03	0.966	0.921	1.013
1993-94	0.306	0.09	351.64	1.006	0.966	1.047
1994-95	0.326	0.103	419.83	1.059	1.085	1.033
1995-96	0.296	0.122	518.47	1.051	1.074	1.029
1996-97	0.298	0.117	556.17	1.02	1.054	0.986
1997-98	0.338	0.146	534.38	1.021	1.043	1
1998-99	0.441	0.202	391.60	1.023	1.108	0.944
1999-00	0.397	0.206	431.92	0.989	0.997	0.981
2000-01	0.602	0.448	219.99	0.921	0.853	0.995
2001-02	0.697	0.577	155.99	0.984	0.963	1.006
2002-03	0.679	0.562	187.29	1.011	1.041	0.982
2003-04	0.762	0.682	125.58	0.998	1.002	0.995
2004-05	0.957	0.942	23.97	1.032	1.026	1.037
2005-06	1.199	1.301	-1.2987	1.014	1.007	1.02
2006-07	1.342	1.544	-3.13559	1.348	1.465	1.241
2007-08	1.334	1.536	-2.42466	1.018	0.984	1.053
2008-09	1.955	2.816	-12.3714	0.91	0.834	0.993
2009-10	1.3	1.437	-3.57576	1.036	1.071	1.002

Source: author's estimates

Because of the time-series nature of calculations for these afore-mentioned indices and before considering the relation between these indices and support policies such as guaranteed price and determining an appropriate econometrics model, the augmented Dickey- Fuller approach was applied to check the stationary data results of the stationary test are shown in Table 2.

As shown in Table 2, the null hypothesis of a unit root is rejected for the first-differenced data. Therefore, we conclude that the series are integrated of order one. Then in order to determine the optimal lag for the co-integration test and the econometrics model, the Schwarz criterion has been considered for each of these equations, results are shown in Table 3. This table shows results from the co-integration tests. Both tests reject the null of zero co-integrating vectors. The hypothesis that there is one co-integrating vector cannot be rejected, however, based solely on the evidence in Table 3 it can be concluded that there is a co-integrating relationship.

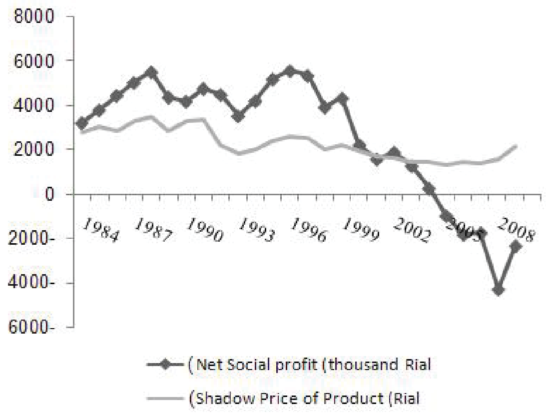

Figure 2. The trend of NSP and shadow price of wheat

In this Table Equ 1 refers to the relation between PSE and NSP, Equ. 2 represent the relation between the guaranteed price of wheat and SAI, Equ. 3 refer to the relation between the guaranteed price of wheat and SA, and finally the relation between subsidies and EAI is expressed by Equ. 4.

Based on the results of Tables 1 and 2, and concerning the stationary degree of variables, the Vector Error correction model has been applied to estimate long run and short-run coefficients of the relation between comparative advantage indices and support policies. Findings are represented in Table 5.

Table 2. Unit root test results

Variables	ADF Statistic	Critical Values	Test for unit root in
Producer Support Estimate	-1.60	-1.77*	1st Difference
Subsidies	-4.28	-5.07**	1st Difference
Guaranteed Prices	-4.28	-5.28**	1st Difference
Scale Advantage Index	-4.32	-5.74*	1st Difference
Efficiency Advantage Index	-4.32	-10.30***	1st Difference
Aggregate Advantage Index	-4.32	-9.40***	1st Difference
Net Social Profit Index	-4.39	-5.75***	1st Difference
Domestic Resource Cost	-4.39	-12.52***	1st Difference
Social Cost - Benefit	-4.39	-6.55***	1st Difference

***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively

Table 3. Results from Co-integration Test

hypothesis	Between PSE & NSP		Between Price & SAI		Between Price & EAI		Between Sub & EAI	
	Trace	Max	Trace	Max	Trace	Max	Trace	Max
H0	15.98	15.98	18.41	18.37	39.42	38.63	20.48	20.00
	(0.0442)	(0.026)	(0.049)	(0.033)	(0.0)	(0.0)	(0.0018)	(0.012)
H1	0.0002	0.0002	0.041	0.041	0.78	0.78	0.47	1.47
	(0.098)	(0.98)	(0.838)	(0.838)	(0.431)	(0.431)	(0.554)	(0.554)

Note: H0 = No co-integration vector; H1= at least one co-integration vector; P-value in parentheses

According to the coefficient of ECM in equation 1, which links the short-run coefficient to their long-run equilibrium values, if a shock enters to the dependent variable, in order to mitigate all effects of the shock, a period of about 1.43 of a year is needed; furthermore in each year approximately 70% of the shock's effect is resolved. Long run coefficients of equation 1 indicate that increasing producer support estimates index resulted in comparative advantage in wheat. In other words, more support to manufacturers led to reduce the competitiveness of wheat products, probably because of non-economical use of cheaper inputs. In equation 2, the relation between scale advantage index (SAI) and guaranteed price is considered. As numbers assert, there is a positive relation, so that an increase in the guaranteed price can improve the rating on the SAI. In addition, if a shock enters the dependent variable, the guaranteed price of wheat is determined by the government in order to adjust all effects of the shock, a period of about 1.45 of a year is needed, furthermore in each year about 68% of the shock's effect is resolved. As demonstrated by previous results the performance of manufacturer support policies (PSE) reduces the competitiveness of wheat products, therefore such levels of support were inefficient, in other words, those resources allocated to support producers, rather than to improve wheat product competitiveness led to increased acreage of wheat and the efficient use of limited land has been missed. In order to check how the guaranteed price is affecting efficiency advantage index (EAI) the relation between these two factors has been considered in equation 3. Based on these findings, even though guaranteed price has had a positive influence on the scale advantage index this policy failed to support a desirable effect on efficiency advantage index (EAI), and has a negative effect on EAI. The error correction term (ECM) in this equation indicates that about 20% of the impact of a shock entered to guaranteed price will be adjusted during one year. The last equation investigates the effect of input subsidies, as another type of support policy, on efficiency advantage index. Results show that subsidies have a negative and significant effect on this index in the long-run; this means that subsidies have failed to have the desired effect to improve the function efficiency of wheat. The coefficient of ECM is (-0.338), which declares about 33 % of shock effects, entered to the independent variable, will be modified toward the long-run equilibrium value in one year.

Table 4. The results of the Schwarz criterion to determine the best lag order

SC	No lag	Lag =1	Lag =2
Equ 1	66.05	83.86	63.84*
Equ 2	13.46	8.73*	8.86
Equ 3	16.45	11.83*	11.92
Equ 4	21.86	19.33*	19.49

Source: findings of study

Conclusions

In summary, Results showed that as producer support is increased, the comparative advantage decreased and the use of cheaper price inputs led to less competitiveness. Although the guaranteed price policy has led to an improvement in Scale advantage index, but has not had a positive effect on the efficiency advantage index. This study suggests that there is a need to perform investigations considering the relationship of cost and world market price and a change from direct support of the agricultural sector to indirect support in the form of structural support, and finally with the implementation of targeted subsidy policy, these multiple goals can be achieved. Therefore, an attempt to implement the strategies that strengthen comparative advantages is a necessity. In fact, the allocation of inputs like fertilizers by government should be appropriate to reduction of production costs and farmers should apply such resources effectively, which it will be accessible by the extension of educational programs and research and development (R&D) institutes. It would be extremely fruitful to pay enough attention to the principle of comparative advantage to maintain self-efficiency in wheat.

Table 5. Results from Estimation of Vector Error Correction Model

Equation	Short-run		Long-run	
	Variable	Coefficient	Variable	Coefficient
Equ 1	ECM	**-0.728***		
		(-2.42)	PSE (-1)	-0.318*
	D NSP(-1)	0.326		(-15.64)
		(0.973)	C	155
	D PSE(-1)	0.141		
		(1.209)		
	C	-63.212*		
		(-2.45)		
	F-statistic	3.55	Log-likelihood	-273.84
Equ 2	ECM	**-0.689***	Price (-1)	8.91 E-05*
		(-4.871)		1.83
	C	0.0317*	C	0.0045
		(4.1)		
	T	-0.00169	T	-1.03
		(-1.22)		
	F-statistic	12.32	Log-likelihood	-237.7
Equ 3	ECM	**-0.2***	Price (-1)	-0.000669*
		(-1.87)		(-4.31)
	C	0.0181	C	0.938
		(0.297)		
	F-statistic	3.52	Log-likelihood	-7.72
Equ 4	ECM	**-0.338***	Subsidies (-1)	-3.92E-05*
		(-2.62)		(-3.04)
	C	0.017	C	-1.24
		(0.29)		
	F-statistic	6.86	Log-likelihood	-7.61

Note: t-ratio in parentheses; *shows the coefficient is significant

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